Records of the Western Australian Museum **20**: 437–439 (2002).

The feasibility of using body proportions in Western Australian varanids (*Varanus*) as a method for determining a specimen's sex

G. G. Thompson

Edith Cowan University, Joondalup Drive, Joondalup, Western Australia, 6027;
g.thompson@ecu.edu.au

Abstract – The literature suggests that varanids are sexually dimorphic based on an array of morphometric variables. Brana (1996) reports that for lacertid lizards, size-corrected abdominal length is always larger in females and head lengths are always larger in males. Thompson and Withers (1997) reported a similar trend for some Western Australian varanids. This study examined the possibility of using a ratio of abdominal length and head length to determine the sex of varanids caught in the field. Although there are statistically significant differences in the mean ratio of abdominal length and head length for males and females for seven species of varanids in the subgenus *Odatria*, overlap in the ratio between males and females is too large for this to be a useful measure by itself. This ratio might, however, be useful when combined with other techniques (such as everting hemipenes) to improve the probability of determining the sex of wild-caught specimens. Ratios of abdominal length and head length for varanids in the subgenus *Varanus* do not differ between sexes.

INTRODUCTION

Sexing varanids in the field can be a problem. Often males of some large varanid species (e.g., *Varanus gouldii* or *V. mertensi*) will evert their hemipenes when they are first caught, clearly indicating that these specimens are males. However, if a particular specimen does not show its hemipenes one can not assume it is a female, as it could be a male that did not evert its hemipenes. Placing pressure on the ventral surface of the tail near where the distal end of where the hemipenes would be and moving the pressure forward can often forcibly evert hemipenes. With practice, this can be a useful method of determining the sex of varanids in the field. However, it has the same problem as alluded to earlier, if a hemipenis is not everted then you can not be confident that the specimen is a female. For some larger species (e.g., *V. mertensi*) hemipenes cannot be everted with pressure applied by the fingers. Reliance on eversion of hemipenes can also be a problem for the inexperienced field worker because of the existence of hemiclitores in females. For some species these structures are partly eversible, and may be quite large (Ziegler and Böhme,1997) and can easily be confused with hemipenes.

For some goanna species in the subgenus *Odatria*, scalation at the base of the tail differs between sexes, with males having enlarged, spinose, post-cloacal scales [e.g., *V. scalaris, V. tristis, V. glauerti, V. pilbarensis, V. glebopalma* (Storr *et al*, 1983; Sweet, 1999)]. Again, for the inexperienced field worker, a male and a female of the same species may be required for comparative purposes to ensure the correct determination of a specimen's sex.

Shea and Reddacliff (1986) and Davis (1991) report ossifications in hemipenes for some varanid species [*V. komodoensis, V. gilleni, V. varius*, (Shea and Reddacliff, 1986); *V. dumerili* (Davis and Phillips, 1991); *V. giganteus* (N. Heger, personal communication); *V. eremius*, unpub data] can be detected in radiographs. Although a useful strategy for sexing mature adults, it is of no value when varanids need to be sexed in the field or are juveniles. Similarly, Morris *et al.* (1998) and Schildger *et al.* (1999) report the use of ultrasound to sex juvenile *V. komodoensis* and adult *V. gouldii* and *V. indicus* respectively, but again this is not a useful strategy in the field because of the equipment requirements.

Thompson and Withers (1997) report Western Australian varanids to be generally sexually dimorphic based on an array of logarithmically transformed body dimensions. However, this method of sexing varanids is of limited value in the field because of the difficulty associated with measuring an array of head and limb dimensions of live and potentially stressed animals. Brana (1996) suggests that for some lacertid lizard species, males have longer heads than females, and females have longer abdomens than males. If this were true for varanids the measurement of a small number of body dimensions could be used to determine the sex of specimens in the field. The objective of this study was to examine the potential of using the ratio of selected body dimensions to determine the sex of varanids in the field.

MATERIALS AND METHODS

Head and abdomen length and head width were measured for 66 *V. caudolineatus*, 50 *V. eremius*, 23 *V. storri*, 33 *V. brevicauda*, 23 *V. gilleni*, 27 *V. acanthurus*, 45 *V. tristis*, 22 *V. mitchelli*, 47 *V. scalaris*, 33 *V. rosenbergi*, 21 *V. giganteus*, 72 *V. gouldii* 21 *V. mertensi*, 26 *V. glauerti*, 10 *V. panoptes panoptes* and 28 *V. glebopalma* specimens that were sexually mature in the Western Australian Museum collection. In addition, 13 *V. indicus* from the Queensland Museum collection were also measured. Head length (HL) was measured from the rear of the tympanum to the front of the snout, abdomen length (BL) was taken as the distance from the point where the fore leg joins the body to the cloaca and head width (HW) was the greatest lateral distance across the head. All measurements were done with vernier callipers to the nearest tenth of a millimetre.

Sex was determined by dissection and examination of the gonads. Juveniles and specimens that had their gonads missing or damaged were not included in the study. A *t*-test was used to determine statistically significant differences between mean values for the ratio BL/HL between sexes for each species. The statistical confidence limit was set at = 0.05.

Table 1 Ratio of abdomen length (BL) and head length (HL) or head length and head width (HW) for male and female Western Australian varanids, with sample size, means, range, 95% confidence limits shown for each of the means and the probability (*P*) of the means coming from the same population shown.

Species	Ratio	Sex	N°	Mean	-1.96SE	1.96SE	*Range*	*P*
Subgenus *Odatria*								
V. acanthurus	BL/HL	M	19	3.434	3.318	3.550	3.062 – 4.088	< 0.01
		F	8	3.785	3.615	3.956	3.485 – 4.161	
V. brevicauda	HL/HW	M	19	1.872	1.817	1.927	1.667 – 2.125	< 0.01
		F	14	2.029	1.943	2.115	1.818 – 2.429	
V. caudolineatus	BL/HL	M	44	3.385	3.324	3.446	2.900 – 4.010	< 0.001
		F	22	3.655	3.565	3.745	3.176 – 4.056	
V. eremius	BL/HL	M	31	2.088	2.039	2.137	2.759 – 3.577	0.15
		F	19	2.028	1.965	2.091	2.750 – 3.607	
V. gilleni	BL/HL	M	13	3.465	3.347	3.583	3.045 – 3.931	< 0.001
		F	10	3.896	3.727	4.065	3.526 – 4.320	
V. glauerti	BL/HL	M	20	3.234	3.146	3.322	2.820 – 3.526	0.50
		F	6	3.274	3.201	3.346	3.188 – 3.444	
V. glebopalma	BL/HL	M	23	3.266	3.203	3.333	2.958 – 3.525	0.04
		F	5	3.160	3.094	3.227	3.048 – 3.238	
V. mitchelli	BL/HL	M	11	3.332	3.148	3.516	2.880 – 3.923	0.046
		F	11	3.611	3.435	3.787	3.187 – 4.200	
V. scalaris	BL/HL	M	35	3.401	3.297	3.505	2.625 – 4.175	< 0.01
		F	12	3.641	3.518	3.764	3.346 – 3.971	
V. storri ocreatus	BL/HL	M	15	2.907	2.846	2.968	2.700 – 3.080	< 0.01
		F	8	3.207	3.044	3.370	2.895 – 3.500	
V. t. tristis	BL/HL	M	22	3.315	3.241	3.389	2.974 – 3.651	0.18
		F	23	3.393	3.311	3.475	2.973 – 3.719	
Subgenus *Varanus*								
V. giganteus	BL/HL	M	13	2.929	2.766	3.092	2.184 – 3.463	0.95
		F	8	2.937	2.745	3.129	2.476 – 3.297	
V. gouldii	BL/HL	M	45	3.466	3.325	3.607	2.385 – 4.253	0.53
		F	27	3.393	3.215	3.571	2.538 – 4.020	
V. mertensi	BL/HL	M	11	3.641	3.386	3.896	3.014 – 4.328	0.10
		F	8	3.982	3.708	4.256	3.488 – 4.808	
V. p. panoptes	BL/HL	M	6	2.845	2.473	3.217	2.324 – 3.721	0.09
		F	4	3.409	2.997	3.821	3.063 – 3.958	
V. rosenbergi	BL/HL	M	20	3.306	3.239	3.373	3.019 – 3.514	0.67
		F	13	3.340	3.199	3.481	2.975 – 3.727	
Subgenus from Indo-Asia								
V. indicus	BL/HL	M	6	3.242	3.046	3.438	3.028 – 3.701	0.24
		F	7	3.398	3.265	3.531	3.229 – 3.615	

RESULTS

The ratio of BL/HL differs significantly between sexes for 7 (*V. acanthurus, V. caudolineatus, V. gilleni, V. glebopalma, V. mitchelli, V. scalaris, V. storri*) of the 17 species examined, and the ratio HL/HW differs significantly between sexes for *V. brevicauda*. All species that have a mean BL/HL or HL/HW ratio that is different for males and females belong to the subgenus *Odatria*. However, these ratios do not differ significantly for several other species in the Odatria (*V. eremius, V. glauerti* and *V. tristis*). For species with a significant difference between sexes, the ratio of BL/HL is greater for females than males indicating that females generally have longer abdomens and males have longer heads or both. BL/HL ratios overlap significantly between sexes for each of these 7 species (Table 1). Ratios of BL/HL did not differ significantly for any species in the subgenus *Varanus*. For *V. brevicauda*, the ratio of BL/HL does not differ significantly between males and females but the ratio of HL/HW does differ significantly between sexes with females having the higher value (Table 1).

DISCUSSION

Mean values for the ratio of BL/HL differ significantly for 7 of 12 species in the subgenus *Odatria*. Comparatively longer abdomens in females and longer heads in males for some goanna species are consistent with findings of Brana (1996). However, because ratios of HL/BL (and HL/HW for *V. brevicauda*) for males and females are not mutually exclusive, the ratio by itself cannot be used as an indicator of a specimen's sex. BL/HL ratios cannot be used to determine sex of any species in the subgenus *Varanus*.

Sweet (1999) provided a useful technique to sex *V. glauerti* and *V. glebopalma*. The size of post-cloacal scales for male *V. glauerti* and *V. glebopalma* are larger than those in females. Post-cloacal scales of females are larger than those in adjacent areas but not as large as those found on males. Diagrams of scales are provided for both sexes enabling comparison to be made. Storr *et al* (1983) provides a diagram of enlarged post-cloacal scales for male *V. scalaris, V. tristis, V. glauerti* and *V. pilbarensis*, however, no indication is provided for the scale size of females. Post-cloacal scales for these species can also be enlarged and an inexperienced field worker can confuse a female for a male without both sexes being available for comparison.

The ratio of BL/HL can at best provide an indication of the sex of some Odatrian specimens caught in the field but it should not be relied upon as BL/HL ratios overlap between sexes. The ratio of BL/HL when used in conjunction with the non-protuberance of hemipenes and the size of post-cloacal scales improves the capacity to predict a specimen's sex in the field.

ACKNOWLEDGEMENTS

Thanks to Ken Aplin and Laurie Smith, and the Western Australian Museum for providing access to the varanids in the Western Australian Museum collection. Eric Pianka provided valuable comments on an early draft.

REFERENCES

Brana, F. (1996). Sexual dimorphism in lactertid lizards: male head increase vs female abdomen increase? *Oikos* **7**: 511–523.

Davis, R.B. and Phillips, L.G. (1991). A method of sexing the Dumeril's monitor, *Varanus dumerili*. *Herpetological Review* **22**: 18–19.

Morris, P.J., Jackintell, L.A. and Alberts, A.C. (1998). Predicting the gender of subadult Komodo dragons (*Varanus komodoensis*) using two-dimensional ultrasound imaging and plasma testosterone concentration. *Zoo Biology* **15**: 341–348.

Schildger, B., Tenhu, H., Kramer, M., Gerwing, M., Kuchling, G., Thompson, G. and Wicker, R. (1999). Comparative diagnostic imaging of the reproductive tract in monitors radiology – ultraonography – coelioscopy. *Mertensiella* **11**: 193–211.

Shea, G.M. and Reddacliff, G.L. (1986). Ossifications in the hemipenes of varanids. *Journal of Herpetology* **20**: 566–568.

Storr, G.M., Smith, L.A. and Johnstone, R.E. (1983). *Lizards of Western Australia II: Dragons and Monitors*. Western Australian Museum, Perth.

Sweet, S.S. (1999). Spatial ecology of *Varanus glauerti* and *V. glebopalma* in Northern Australia. *Mertensiella* **11**: 317–366.

Thompson, G.G. and Withers, P.C. (1977). Comparative morphology of Western Australian varanid lizards (Squamata: Varandidae). *Journal of Morphology* **233**: 127–152.

Ziegler, T. and Böhme, W. (1997). Genitalstrukturen und paarungsbiologies bei squamaten reptilien, speziell den platynota, mit bemerkungen zur systematik. *Mertensiella* **8**: 1–207.

Manuscript received 1 February 2001; accepted 6 June 2001.